THUMB-OPERABLE MAN-MACHINE INTERFACES (MMI) FOR PORTABLE ELECTRONIC DEVICES, PORTABLE ELECTRONIC DEVICES INCLUDING THE SAME AND METHODS OF OPERATING THE SAME

BACKGROUND OF THE INVENTION

The present invention relates to portable electronic devices and, more particularly, to man-machine interfaces (MMIs) used to access functionalities of portable electronic devices.

Manufacturers and designers of portable electronic devices, such as mobile telephones, frequently seek to reduce the overall dimensions of such devices while maintaining attractive style characteristics for the devices. One consequence of the reduced size for such devices is that less space may be available for the required components that provide the necessary functionality of the phone as well as components that provide additional functionality. As the space available for the hardware components decreases in the portable electronic devices, it may become more difficult to support additional functionality.

Portable electronic devices typically include at least one man-machine interface (MMI) that allows a user of the electronic device to access the functionalities provided by the portable electronic device. Conventional MMIs may include keypads, touchscreens, computers coupled to the portable electronic device through, for example, a serial connector, a joystick and/or a jogdial. Conventional MMIs, such as a keypad, may occupy a large percentage of the space on the portable electronic device, which may cause the overall size of portable electronic devices to increase. Furthermore, a user may have to use both hands to operate a keypad of other conventional MMI, which may be inconvenient for the user in certain situations. Accordingly, improved MMIs for portable electronic devices may be desired.

SUMMARY OF THE INVENTION

Embodiments of the present invention provide portable electronic devices including a housing and a display integrated with the housing. A thumb-operable input device is positioned on a side of the housing. An indicator is provided on the

display and is operatively associated with the thumb-operable input device. The indicator is positioned on the display to highlight and/or select menu items on the display responsive to input received at the thumb-operable input device.

In some embodiments of the present invention, the thumb-operable input device may further include at least one thumb position sensor. The thumb position sensor may be configured to detect a position of a thumb on the thumb-operable input device and move the indicator on the display between the menu items responsive to the position of the thumb on the thumb-operable input device.

In further embodiments of the present invention, the thumb-operable input device may further include at least one thumb movement sensor configured to detect movement on the thumb-operable input device and a processor operatively associated with the at least one thumb movement sensor. The processor may be configured to process the detected movement and move the indicator on the display between the menu items responsive to the processed movement. The thumb movement sensor may be further configured to detect movement via fingerprint analysis. In these embodiments, the thumb movement sensor may be further configured to detect distortion of a fingerprint on the thumb-operable input device. The processor may be configured to process the detected distortion of the fingerprint and highlight and/or select menu items on the display responsive to the detected distortion.

In still further embodiments of the present invention, the thumb-operable input device may include a slot, a plurality of notches in the slot and a bar configured to move in the slot. Ones of the plurality of notches may be associated with ones of a plurality of menu items. The bar may be configured to move in the slot between the notches to position the indicator on the display to highlight and/or select the associated menu item.

In some embodiments of the present invention, a sensor may be operatively associated with the bar and configured to detect movement of the bar in the slot. A processor may be operatively associated with the sensor. The processor may be configured to process the detected movement of the bar and move the indicator on the display between the menu items responsive to the processed movement.

In further embodiments of the present invention, the thumb-operable input device may include a slot and a bar. The bar may be configured to slide in the slot to position the indicator on the display to highlight and/or select one of a plurality of menu items. The device may further include a sensor operatively associated with the

bar and configured to detect movement of the bar in the slot. A processor may be provided that is operatively associated with the sensor. The processor may be configured to process the detected movement of the bar and move the indicator on the display between the menu items responsive to the processed movement. In certain embodiments of the present invention, the thumb-operable input device may further include a spring mechanism. The spring mechanism may be configured to reposition the bar at an end of the slot between selections of menu items.

In still further embodiments of the present invention, the thumb-operable input device may include at least one of a fingerprint sensor, touchpad or hinged bar. The indicator may be configured to move between menu items responsive to upward and/or downward movement on the fingerprint sensor, the touchpad or the hinged bar.

In some embodiments of the present invention, the thumb-operable input device may include a touchpad positioned on a side of the housing. In certain embodiments of the present invention, a sensor may be provided that is operatively associated with the touchpad and configured to detect movement on the touchpad. A processor may be provided that is operatively associated with the sensor. The processor may be configured to process the detected movement on the touchpad and move the indicator on the display between the menu items responsive to the processed movement.

While the present invention is described above primarily with reference to portable electronic devices including MMIs, MMIs and methods of operating portable electronic devices are also provided.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a schematic diagram of mobile terminals according to some embodiments of the present invention and an exemplary base station transceiver.

Figure 2 is a schematic diagram illustrating man-machine interfaces (MMIs) according to some embodiments of the present invention.

Figure 3 is a schematic diagram illustrating keypads and indicators according to some embodiments of the present invention.

Figure 4 is a schematic diagram illustrating MMIs according to further embodiments of the present invention.

Figure 5A is a schematic diagram illustrating MMIs according to still further embodiments of the present invention.

Figure 5B is a schematic diagram illustrating MMIs according to some embodiments of the present invention.

Figure 6 is a schematic diagram illustrating MMIs according to further embodiments of the present invention.

Figure 7 is a schematic diagram illustrating MMIs according to still further embodiments of the present invention.

Figure 8 is a flowchart illustrating operations of portable electronic devices according to embodiments of the present invention.

DETAILED DESCRIPTION

The present invention now will be described more fully hereinafter with reference to the accompanying drawings, in which illustrative embodiments of the invention are shown. In the drawings, the relative sizes of regions or features may be exaggerated for clarity. This invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art. It will be understood that when an element is referred to as being "coupled" or "connected" to another element, it can be directly coupled or connected to the other element or intervening elements may also be present. In contrast, when an element is referred to as being "directly coupled" or "directly connected" to another element, there are no intervening elements present. Like numbers refer to like elements throughout. As used herein the term "and/or" includes any and all combinations of one or more of the associated listed items.

Embodiments of the present invention will now be described below with respect to **Figures 1** through **8**. Embodiments of the present invention provide man-machine interfaces (MMIs) for portable electronic devices, for example, mobile terminals, including a thumb-operable interface device that controls an indicator on a display of the portable electronic device to allow a user to access the functionalities provided by the portable electronic device. An indicator is provided on the display and is operatively associated with the thumb-operable input device. In other words, the indicator is positioned on the display to highlight and/or select menu items on the display responsive to input received at the thumb-operable input device. Accessing the functionalities of the portable electronic device according to embodiments of the

present invention may allow a conventional MMI, for example, a keypad, to be omitted from the portable electronic device, which may further allow the overall size of the portable electronic device to be decreased. Furthermore, thumb-operable input devices according to some embodiments of the present invention may enable single-handed operation of the electronic device, which may improve the overall convenience of use of the portable electronic device.

As used herein, "thumb-operable" refers to the intended operation of the device as illustrated, for example, in **Figure 2**. However, "thumb-operable" is not intended to exclude the possibility that the device may be operated using some other means. In other words, if a user chooses to operate MMIs according to embodiments of the present invention with his or her index finger, the MMI may still be within the scope of the present invention.

The present invention is described below with reference to schematic and block diagrams of MMIs and devices including the same according to embodiments of the invention. Embodiments of the present invention may be used in conjunction with a mobile terminal, for example, a mobile terminal **22** of **Figure 1**. Although MMIs are discussed herein as being included as part of a mobile terminal, embodiments of the present invention are not limited to this configuration.

Figure 1 illustrates an exemplary radiotelephone communication system, in accordance with embodiments of the present invention, which includes the mobile terminal **22** and a base station transceiver **24** of a wireless communications network. The mobile terminal **22** includes a portable housing **23** and may include a display **28**, a speaker **32**, a microphone **34**, a transceiver **36**, and a memory **38**, any of which may communicate with a controller/processor **42**. Furthermore, mobile terminals **22** according to embodiments of the present invention may further include at least one MMI **26** according to embodiments of the present invention and a sensor **29** associated with the MMI **26**, which also communicate with a controller/processor **42**. The processor **42** can be any commercially available or custom microprocessor.

The transceiver **36** typically comprises a transmitter circuit **44** and a receiver circuit **46**, which respectively transmit outgoing radio frequency signals to the base station transceiver **24** and receive incoming radio frequency signals, such as voice signals, from the base station transceiver **24** via an antenna **48**. The radio frequency signals transmitted between the mobile terminal **22** and the base station transceiver **24** may comprise both traffic and control signals (*e.g.*, paging signals/messages for

incoming calls), which are used to establish and maintain communication with another party or destination. The controller/processor **42** may support various functions of the mobile terminal **22**, including processing signals sensed by the sensor **29** for the MMI **26** with respect to user input and providing signals generated by the sensor **29** to the display **28** so as to allow an indicator on the display to highlight and/or select menu items according to some embodiments of the present invention.

As used herein, the term "personal electronic device" or "mobile terminal" may include: a cellular radiotelephone with or without a multi-line display; a Personal Communications System (PCS) terminal that may combine a cellular radiotelephone with data processing, facsimile and data communications capabilities; a Personal Data Assistant (PDA) that can include a radiotelephone, pager, Internet/intranet access, Web browser, organizer, calendar and/or a global positioning system (GPS) receiver; and a conventional laptop and/or palmtop portable computer that may include a radiotelephone transceiver.

In some embodiments of the present invention, the base station transceiver **24** comprises the radio transceiver(s) that defines an individual cell in a cellular network and communicates with the mobile terminal **22** and other mobile terminals in the cell using a radio-link protocol. Although only a single base station transceiver **24** is shown, it will be understood that many base station transceivers may be connected through, for example, a mobile switching center and other devices to define a wireless communications network.

Although the present invention may be embodied in communication devices or systems, such as the mobile terminal **22**, the present invention is not limited to such devices and/or systems. Instead, the present invention may be embodied in any apparatus that may utilize a MMI according to embodiments of the present invention.

Referring now to **Figure 2**, a portable electronic device **200**, for example, the mobile terminal **22** of **Figure 1**, including a MMI **215** according to embodiments of the present invention will be discussed. As illustrated in **Figure 2**, the portable electronic device **200** includes a display **203** including one or more menu items. The menu items illustrated in **Figure 2** include messages **210**, call log **220**, profiles **230**, settings **240**, system **250**, games **260**, calculator **270**, keypad **280** and phone book **290**. It will be understood that the menu items illustrated in **Figure 2** are provided for exemplary purposes only and that embodiments of the present invention are not limited to this configuration. The display **203** further includes an indicator or cursor

205. The MMI of the portable electronic device **200** is provided by a thumb-operable input device **215** provided on a side of the housing **201** of the portable electronic device **200**. As illustrated in **Figure 2**, MMIs according to embodiments of the present invention may be configured for single-handed operation. Although the thumb-operable input device **215** is provided on a side of the housing **215** in **Figure 2**, embodiments of the present invention are not limited to this configuration. The thumb-operable input device **215** may be positioned anywhere on the portable electronic device **200** without departing from the scope of the present invention.

The indicator **205** on the display **203** is operatively associated with the thumb -operable input device **215**. The indicator **205** is positioned on the display to highlight and/or select menu items, for example, the messages **210** menu item as illustrated in **Figure 2**, on the display **203** responsive to input received at the thumb-operable input device **215**. A sensor, for example, sensor **29** of **Figure 1**, may be operatively associated with the thumb-operable input device **215** and may be configured to detect movement on the thumb-operable input device **215**. A processor, for example, processor **42** of **Figure 1**, may also be provided in the portable electronic device **200**. The processor may be operatively associated with the sensor and configured to process the detected movement on the thumb-operable input device **215**. The indicator **205** may be moved on the display **203** between the menu items responsive to the processed movement. Details with respect to movement of the indicator and highlighting and/or selecting menu items will be discussed further below with respect to **Figures 4** through **7**.

When a menu item, for example, the keypad **280** menu item, is selected a submenu may appear on the display **203**. In particular, if the keypad **280** menu item is selected a submenu **300** including items typically included on a conventional keypad may appear on the display **203** as illustrated in **Figure 3**. The thumb-operable input device **215** may be used to highlight and/or select items from the submenu **300** to, for example, dial a phone number. It will be understood that the submenu **300** of the keypad **280** illustrated in **Figure 3** is provided for exemplary purposes only and that embodiments of the present invention are not limited to this configuration. It will also be understood that some or all of the remaining menu items may contain similar submenus. For example, submenus for the settings **240** may include volume control, display settings, and the like. The potential contents of the submenus are known to those of skill in the art and will not be discussed further herein.

Referring now to **Figure 4**, portable electronic devices **400** including MMIs according to some embodiments of the present invention will be discussed. The details with respect to the housing **401**, the display **403**, the indicator **405** and the menu items **410** through **490** are discussed above with respect to similar components in **Figure 2** and need not be repeated herein. As illustrated in **Figure 4**, the MMI or thumb-operable input device may include at least one thumb movement sensor **416**. The thumb movement sensor **416** is configured to detect movement of, for example, a thumb on the sensor **416**. In other words, the thumb movement sensor **416** may be configured to sense, for example, a sliding motion of the thumb. The sensor **416** may sense up, down and/or side-to-side motion. The motion of the thumb sensed by the thumb movement sensor **416** may be processed by a microprocessor, for example, processor **42** of **Figure 1**, and the indicator **405** may move responsive to the signal processed by the microprocessor.

In some embodiments of the present invention, the thumb movement sensor **416** may use fingerprint analysis to determine motion of the thumb and the direction of the motion. In other words, the sensor **416** may be configured to recognize the pattern of a fingerprint of a thumb or finger operating the thumb-operable input device. For example, if the recognized pattern appears to be moving from a high position to a relatively lower position on the sensor **416**, this may cause the indicator to move down the list of menu items or toward the bottom of the display **403** until the movement stops. Similarly, if the recognized pattern appears to be moving from a low position to a relatively higher position on the sensor **416** or a different horizontal position, this may cause the indicator to move up the menu list on the display **403** or from side to side, respectively, until the movement stops.

Furthermore, once the indicator **405** is positioned to highlight the desired menu item, the menu item may be selected using a different pressing sequence or a unique press. For example, the sensor **416** may be configured to sense pressure being placed on the sensor **416** by, for example, a thumb. In embodiments of the present invention using fingerprint analysis, the ridges of the fingerprint may flatten out or distort when more pressure is applied to the sensor **416**. Similarly, when the thumb or finger is removed from the sensor **416**, the ridges of the fingerprint will disappear. In some embodiments of the present invention, the sensor **416** may be configured to detect distortion of only a portion of the fingerprint, *i.e.* uniform pressure may not be applied to the sensor **416** by the thumb. For example, if a thumb makes a rolling

motion up without actually moving the central position of the thumb on the sensor **416**, the fingerprint may only flatten out or become distorted at a top portion of the fingerprint. The processor **42** (**Figure 1**) may be configured to detect the distortion in pressure on the top portion of the fingerprint and move the indicator **405** up the menu until uniform pressure is returned to the sensor **416**. Accordingly, the sensor **416** may be configured to select a highlighted menu item when relatively more pressure is applied to the sensor **416** either by the whole thumb or portions of the thumb. Furthermore, a second distinct pressing sequence may used to activate the selected menu item. For example, if the seven digits of a phone number have been selected and are displayed on the display **403**, two consecutive taps on the sensor **416** may dial the phone number. The details of fingerprint analysis are known to those having skill in the art and need not be discussed in detail herein.

Some embodiments of the present invention may include a timing circuit (designated at **30** of **Figure 1**). The timing circuit **30** may be configured to start a timer when a first tap is sensed and to wait for a predetermined period of time for a second tap. If a second tap is sensed by the sensor **416** within the predetermined period of time, the highlighted selection on the display **403** may be selected and, for example, the phone number may be dialed. It will be understood that the pressing sequences discussed above are provided for exemplary purposes only and embodiments of the present invention should not be limited by these example. For example, the timing circuit may be configured to set a timer when a menu item is highlighted and to select the menu item if the timer expires and the menu item is still highlighted without departing from the scope of the present invention.

Referring now to **Figure 5A**, portable electronic devices **500** including MMIs according to some embodiments of the present invention will be discussed. The details with respect to the housing **501**, the display **503**, the indicator **505** and menu items **510** through **590** are discussed above with respect similar components in **Figure 2** and need not be repeated herein. As illustrated in **Figure 5A**, the MMI or thumb-operable input device may include a slot **515**, one or more notches **517** in the slot and a bar **516** configured to slide in the slot. Ones of the notches **517** may be associated a respective one of the menu items. The bar **516** is configured to slide in the slot **515** between the notches **517** to position the indicator **505** on the display to highlight and/or select the menu item associated with the notch. Thus, as discussed above with respect to **Figure 4**, the indicator **505** may be positioned to highlight a desired menu

item on the display. The desired menu item or items, once highlighted, may be selected by pushing the bar **516** or tapping the bar **516** multiple times as discussed above. In other words, a sensor, for example, sensor **29** of **Figure 1**, may be operatively associated with the bar **516** and configured to detect movement of the bar **516** in the slot **517**. A processor, for example, processor **42** of **Figure 1**, may be operatively associated with the sensor **29**. The processor **42** may be configured to process the detected movement of the bar **516** and move the indicator on the display between the menu items responsive to the processed movement.

Some embodiments of the present invention may include the slot **515'** and the bar **516'** without including the notches **517** as illustrated in **Figure 5B**. These embodiments may include a spring mechanism **518** configured to reposition the bar **516** at an upper end of the slot **515** between selections of menu items. In other words, the menu item that is highlighted just before the bar **516** returns to the top or bottom of the slot **515** is selected.

Referring now to **Figure 6**, portable electronic devices **600** including MMIs according to some embodiments of the present invention will be discussed. The details with respect to the housing **601**, the display **603**, the indicator **605** and the menu items **610** through **690** are discussed above with respect to **Figure 2** and will not be repeated herein. The MMI or thumb-operable input device may include, for example, a hinged bar **615**. The thumb-operable input device **615** may be configured to be responsive to slight movements of the hinged bar. Although embodiments of the present invention are discussed with respect to a hinged bar, embodiments of the present invention are not limited to this configuration. For example, the thumb-operable input device of **Figure 6** may be, for example, a touchpad or a fingerprint sensor without departing from the scope of the present invention. The indictor **605** may move between menu items responsive to repetitive upward and/or downward motion with respect to the hinged bar **615**. For example, if the hinged bar **615** is pressed and held down, the indicator **605** may move down the list of menu items until the pressure on the hinged bar **615** is released. Similarly, if the hinged bar **615** is pressed and held up, the indicator **605** may move up the list of menu items until the pressure of the hinged bar **615** is released.

Embodiments of the thumb-operable input device **615** illustrated in **Figure 6** may include a sensor, for example, sensor **29** of **Figure 1**, operatively associated with the hinged bar and configured to detect the slight movements of the hinged bar. A

processor, for example, processor **42** of **Figure 1**, may be operatively associated with the sensor. The processor **42** may be configured to process the detected movement of the hinged bar **615** and move the indicator **605** on the display between the menu items responsive to the processed movement.

Referring now to **Figure 7**, portable electronic devices **700** including MMIs according to some embodiments of the present invention will be discussed. The details with respect to the housing **701**, display **703**, indicator **705** and menu items **710** through **790** are discussed above with respect to **Figure 2** and will not be repeated herein. As illustrated, the MMI or thumb-operable input device includes a thumb position sensor **715**, for example, a touchpad sensor, on a side of the housing **701** of the portable electronic device **700**. The place where a thumb or finger touches the thumb position sensor **715** may be translated by the microprocessor, for example, processor **42** of **Figure 1** into a location on the display **703** and the indicator **705** is positioned at this location on the display. In other words, the position of a centroid of the thumb on the thumb position sensor **715** may directly correspond to a position of the indicator **705** on the display **703**. In some embodiments of the present invention the thumb position sensor **715** may include a plurality of touchpad sensors, each of which may be configured to correspond to one or more of the menu items without departing from the teachings of the present invention.

Referring now to **Figure 8**, operations of portable electronic devices including MMIs according to still further embodiments of the present invention will be discussed. Operations begin at block **800** by detecting movement on the thumb-operable input device. It will be understood that a thumb-operable input device may be a thumb-operable input device according to embodiments of the present invention discussed above with respect **Figures 2** through **7**. For example, the thumb-operable input device may include, for example, a sensor, a fingerprint sensor, a hinged bar, a touchpad, a sliding bar in a slot and the like without departing from the scope of the present invention.

The movement detected on the thumb-operable input device (block **800**) may be processed by, for example, processor **42** of **Figure 1** (block **810**). The indicator may be moved between menu items on the display in response to the processed movement (block **820**). As discussed above, the indicator may be positioned on the display using the thumb-operable input device to highlight and/or select menu items on the display responsive to input received at a thumb-operable input device. The

menu items may include, for example, include menu associate with messages, a call log, profiles, settings, the system, games, a calculator, a keypad, a phone book and the like without departing from the teachings of the present invention.

As briefly discussed above with respect to **Figures 1** through **8**, embodiments of the present invention provide a man-machine interface (MMI) or thumb-operable input device for portable electronic devices. The thumb-operable input device may allow single-handed operation of a portable electronic device as illustrated in **Figure 2**, which may eliminate the need for a stylus and/or keypad and simplify the overall operation of the portable electronic device. Furthermore, the presence of, for example, a keypad as a menu item may eliminate the need for an actual keypad on the portable electronic device, which may allow the overall size of the device to be reduced.

In the drawings and specification, there have been disclosed typical illustrative embodiments of the invention and, although specific terms are employed, they are used in a generic and descriptive sense only and not for purposes of limitation, the scope of the invention being set forth in the following claims.